UNIVERSITI PUTRA MALAYSIA

DESIGN AND DEVELOPMENT OF TRAFFIC LIGHT FAULT DETECTION SYSTEM

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By

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Thesis Submitted in Fulfilment of the Requirement for the Degree of Master of Science in the Faculty of Engineering Universiti Putra Malaysia

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SPECIAL
DEDICATION
TO:

Family & Best Friend

"Love You all"

ACS 2001

Abstract of thesis presented to the Senate of Universiti Putra Malaysia
in fulfilment of the requirement for the degree of Master of Science

DESIGN AND DEVELOPMENT OF TRAFFIC LIGHT FAULT DETECTION SYSTEM

By

AZURA BINTI CHE SOH

October 2001

Chairman: Samsul Bahari Mohd Noor, Ph.D.

Faculty: Engineering

Traffic light is normally installed at junctions to ensure smooth running of traffic. It is common to see a little signboard that displays telephone number to contact in case of malfunction. This solely depends upon the willingness of the road users to inform the authority. It may be malfunction for a day or more. This in turn will create problem to the users. Therefore, an automatic fault detection system that will send a message to the authorities would be required.

In order to do that, a survey has been conducted to evaluate the behaviour of road users when approaching a junction. Based on that, different failures were grouped into three categories i.e. Highly Critical, Critical and Non Critical.

A system to detect the condition of the lights based on the categories has been developed using photodarlington and combinational logic. The system has been simulated, implemented and tested successfully. Output of the system is fed to a microcontroller based system that will send out messages to control room when failures occurs which will then be displayed together with the category of the failure. The system is now ready to be tested on the real traffic lights.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk Ijazah Master Sains

MEREKABENTUK DAN MEMBANGUNKAN SISTEM PENGESAN KEROSAKAN LAMPU ISYARAT

Oleh

AZURA BINTI CHE SOH

Oktober 2001

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Penggunaan lampu isyarat di persimpangan jalan biasanya adalah untuk memastikan kelancaran lalulintas. Biasanya terdapat papan tanda di persimpangan yang tertera nombor telefon untuk dihubungi jika berlakunya kes kerosakan. Ia juga hanya bergantung kepada kesediaan pengguna jalan raya untuk menghubungi pihak berkuasa. Sekiranya pengguna jalan raya tidak menghubungi pihak berkuasa, ia akan menyebabkan lampu isyarat tidak berfungsi untuk satu hari atau lebih. Ini akan menimbulkan masalah kepada pengguna jalan raya. Oleh kerana itu, sistem pengesan kerosakan automatik diperlukan untuk menghantar mesej kepada pihak berkuasa.

Kajian soal-selidik telah dilakukan untuk menilai tingkah laku pengguna jalan raya semasa menghampiri persimpangan. Kerosakan-kerosakan yang berbeza boleh diklasifikasikan kepada tiga kategori iaitu *Terlampau Kritikal*, *Kritikal* dan *Kurang Kritikal*.

Sistem yang digunakan untuk mengesan keadaan lampu-lampu pada lampu isyarat bergantung kepada kategori yang telah dibina dengan menggunakan photodarlington dan litar logik kombinasi. Sistem pengesan kerosakan tersebut telah berjaya disimulasi, dibina dan diuji sepenuhnya. Keluaran bagi sistem tersebut akan dimasukkan kepada pengawal mikro di mana ia akan menghantar mesej ke bilik kawalan jika berlakunya kerosakan. Mesej tersebut akan memaparkan jenis kerosakan lampu isyarat bergantung kepada tiga kumpulan yang telah dikategorikan. Sekarang, sistem tersebut sudah siap untuk diuji pada lampu isyarat.

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I certify that an Examination Committee met on 15th October 2001 to conduct the final examination of Azura Che Soh on her Master of Science thesis entitled " Design and Development of Traffic Light Fault Detection System" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfilment of the requirement for the degree of Master of Science.

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I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

AZURA CHE SOH

Date: 21/11/2001

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LIST OF ABBREVIATIONS

ATC	- Area Traffic Control
ALU	- Arithmetic Logic Unit
CMOS	- Complementary Metal Oxide Semiconductor
CPU	- Central Processing Unit
CISC	- Complex Instruction Set Computer
DIP	- Dual In-Line Package
EPROM	- Electrically Programmable Read Only Memory
EEPROM	- Electrically Erasable Programmable Read Only Memory
IC	- Integrated Circuit
I/O	- Input/Output
IR	- Infra-Red
K-map	- Karnaugh Map
LED	- Light Emitting Diode
LCD	- Liquid Crystal Display
LASCR	- Light Activated Silicon-Controller Rectifier
LRT	- Light Rapid Transit
MCU	- Microcontroller Unit
OTP	- One Time Programmable
PC	- Personal Computer
PIC	- Peripheral Interface Controller
PICs	- Peripheral Interrupt Controller
PLC	- Programmable Logic Controller
PLD	- Programmable Logic Device
RISC	- Reduced Instruction Set Computer

ROM	- Read Only Memory
RAM	- Random Access Memory
SCATS	- Sydney Co-Ordinated Adaptive Traffic System
UV	- Ultra Violet
VHDL	- Very High Speed Integrated Circuit Hardware Description Language

CHAPTER 1

INTRODUCTION

1.1 Importance and Demand of Traffic Control System

The monitoring and control of city traffic is becoming a major problem in many countries. With the ever-increasing number of vehicles on the road, the Traffic Monitoring Authority or the Transport Ministry as the authority is known here in Malaysia, has to find new ways or measures of overcoming such problem. The measures taken are development of new roads and flyovers in the middle of the city; building of several ring such as the inner ring road, middle ring road and outer ring road; introduction of city trains such as the light rapid transit (LRT), and monorails; restricting of large vehicles in the city during peak hours; and development of sophisticated traffic monitoring and control systems (Kok Khiang Tan et.al, 1996).

Modernization and developments of towns and cities are going in fast pace each year. This is due to the sharp increase of traffic volume. The demand for more road space than supply can result in congestion. Congestion usually happens at junctions and during rush hours. Also at a junction, traffic conflict can arise where the road users get confused who have the priority to proceed first and who is suppose to stop and wait. Traffic conflict can lead to accidents where most accidents usually happen at road junctions.

Traffic light should be installed when they alleviate more problems. This must be determined on the basis of an engineering study. Those red, yellow and green traffic signal lights are vital to controlling traffic in safe, orderly manner. They let motorists "take turns" in moving through busy intersections and can enhance safety. A warranted traffic light, which properly located and operated may provide a more orderly movement of traffic. On the other hand, an unwarranted traffic light can result in increased delay, congestion, and accidents. A potential accident exists every time a vehicle is stopped on the traveled portion of a highway.

As a result the increase of traffic and needs a reliable traffic light to solve the complexity of the traffic. Traffic light is designed to ensure a safe and orderly flow of traffic, provide safety for pedestrians or vehicles while crossing a busy intersection, and help lessen the severity and frequency of accidents between vehicles entering intersections from different directions. Many people seem to believe that traffic lights are the answer to all traffic problems at intersections.

1.2 Problems That Occurred When Traffic Light Malfunction

A long-standing problem in traffic engineering is to optimize the flow of vehicles through a given road network. Improving the timing of traffic signals at intersections in the network is generally the most powerful and cost-effective means of achieving this goal. However, because of the aspects of traffic system, human behavioral considerations vehicles flow interactions within the network, weather effects, traffic accidents, long-term (e.g. seasonal) variation, etc, it has been notoriously difficult to determine the optimal signal timing. The neural network function uses current traffic information to solve the current (instantaneous) traffic problem on a system-wide basis through an optimal signal timing strategy has been proposed by Spall et. al. (1997).

An optimal control problem of traffic light duration is considered and discussed by Stoilova and Stoilov (1998). The traffic noise level is introduced as a state variable in a dynamical optimization problem. A closed loop control system is designed which influences the green duration of the lights according to the equivalent noise level real time considerations lead to sub-optimal control implementation. This control policy decreases the noise levels at intensive traffic intersections. The traffic lights adapt their duration according to the noise pollution.

Retting et. al. (1998) have done a research efforts to examine the problem of red-light running and the use of countermeasure including red-light cameras to reduce the problem. Deliberate running of red lights is a common and serious violation that contributes substantially to the more than 1 million motor vehicle collisions that occur at traffic signals each year. Urban-based highway safety research has examined various aspects of the red-light running problem including the contribution of red-light violations to motor vehicle crashes, the frequency of red-light running characteristics of the red-light runners and influence of signal timing on red-light running behavior.

A conflict study by Tarrall et. al. (1998) evaluated double left-turn lanes with protected-plus-permitted signal phasing. The data collection team observes traffic behavior at four intersections in the Atlanta region. Included in the data set are three intersections with a before and after examination of protected-plus-permitted signal phase changed to protected-only phasing. The researchers calculated the traffic rates for five conflicts types and one traffic event unique to double movements. A statistically significant decrease in traffic conflicts was identified for the before and after comparison site. The study also identifies unique intersection geometry and traffic volumes at each site and compares traffic conflicts associated with the features.

The researchers from Hong Kong Polytechnic University (Mung et. al., 1998) have carried out a the research about the probability distribution of maximum number of opposed turns in a signal cycle is derived for a fixed time signalized intersection. Three cases have been studied separately: (i) no turning vehicles can pass through the truncated gap, which occurs when one of the effective green period falls in a gap of the opposing straighthead vehicles, (ii) at least one turning vehicle can pass through the truncated gap and (iii) the end of the effective green period does not fall in a gap. The derived probability distribution can be utilized to improve the signal design for the opposed turning traffic.

1.3 Objective

In this project, a system is to be developed that will detect whenever failure occurs. It should also be able to classify severity of the fault and the relevant parties will be notified. Since correct operation of traffic light is crucial, monitoring its state is also important. Any fault and malfunction should be reported to the local authority for repair and traffic police should be called in some cases to ensure a smooth traffic movement.

1.4 Thesis Organization

This thesis consists of five chapters. Chapter 1 describes the importance and demands of traffic control system at the intersection or junction. It also includes the problem statement and objective of the project. Literature reviews of related subjects, concepts and theory to this project are presented in Chapter 2. Chapter 3 gives a detail descriptions on the methodologies used in the project. This chapter explains how a survey has been conducted, hardware design of Traffic Light Fault Detection system and software design to interface with the microcontroller. Chapter 4 presents the results and discussion. It also explains the testing of the hardware and software design. Finally, the works are concluded in Chapter 5. The achievement, problems and future suggestions are also described in this chapter.